David Rumsey

THE SPEED OF WELTE'S ORGAN ROLLS

The Problem

«Gerade bei Interpretationen von Orgelmusik Max Regers erschienen uns die Tempi jedoch deutlich als zu langsam ... Gegenüber der von Bosch vorgeschlagenen Drehzahl lief der Windmotor in der neuen Einstellung um einiges schneller – wir kamen zu rund zwanzig Prozent rascheren Tempi»

Peter Hagmann:
Das Welte-Mignon-Klavier, die Welte-Philharmonie-Orgel und die Anfänge der Reproduktion von Musik, 1984 (pp. 85–89)

"The release of those Reger recordings in the 1960s was the worst thing that could have happened for the cause of roll-recordings being taken seriously"
(comment of a visitor to Seewen 9th August 2012)

The speed with which the paper moves over tracker-bars is critical if roll recordings are to accurately reproduce a performance. The faster the playback rolls run compared to the original recording speed, the quicker the tempo will be. It is also critical for the mechanisms which rolls control: if too fast, then repeated notes do not repeat, or staccato notes might not sound at all. Swell movements depend on their activating signal-lengths, so correct playback speed is also critical here. Dynamic control on piano-players or wind-sufficiency in organs can also be affected, since unintended heavy demands can overload wind-supplies. The most problematic component in this chain is Welte's wind motor which drives the roll transport system.

Fig. 1 – Speed lever on a Philharmonie

Yet Welte allowed operators to select their own speeds by means of a lever. A central position as well as "slower" and "faster" were marked. In a well-regulated system the central position is presumably the correct speed, although more by implication than expressly stated. The fact that they provided this facility at all is interesting: compensating for worn and inaccurately running mechanisms? Or pepping up a not so interesting performance? A similar facility was also advertised by the firm for registration, offering options of switching stops in and out. It gave owners a feeling of control, seemingly a significant sales pitch.

We might thus conclude that accuracy of registration and tempo were not a major priority of the firm. There is evidence of intervention in roll-editing by Welte that could endorse such a view. Different Welte models required stop-patching systems that automatically distorted the organists' registrations, tailoring the full-organ effects to the size of the organ rather than the organists' original resources.

However, it is equally evident that Welte took correct tempo and registration very seriously at the time of recording. The recorder now preserved at Seewen was driven, not by a pneumatic motor, but by three strong electric motors. Registration was also noted by an observer present at the recording.[1] Swell-pedal movements were recorded by a system capable of finer nuances than human perception needed: up to 10 incremental stages.[2] Edwin Lemare's comment, "correct at last", on the W1181 master roll leaves no doubt about this striving for recording accuracy.

The "tractor"[3], used for making commercial copies of rolls from masters, gives the impression of a system that would accept no unwished-for speed changes.

The question of roll-speeds was noted when Hagmann assessed the mechanism on the Seewen organ as having run about 20 % too slowly.[4] The effect on tempi was one of several highly negative factors contributing to the loss of credibility in rolls for late 20th-century analyses of historic performance paradigms.[5]

Hagmann estimated a speed of 3 metres/minute at the very start of play (constant rotation speed meant this increased while rolls wound onto their take-up spools). This was tested by Daniel Debrunner, the author and others around the time that the scanning of the Seewen organ rolls commenced in

Fig. 2 – "The tractor" used for roll duplication now in the possession of David Krall, USA

late 2009. The organ player software permitted a wide range of alteration to this figure, should future research refute it. Compensation for the incremental widening of reel diameters was also built into the playback computer program.[6] Normal playback needed no such compensation since all Welte's organ take-up spools had the same diameter.[7] Nelson Barden noted longer perforations at the end of rolls than at the beginnings[8] but Welte's playback parameters automatically neutralized these slowing effects[9]. Rolls of 15 – 20 minutes' duration can end up at around twice the diameter they began with – producing four times the paper-speed, although paper loading can also slow the pneumatic motors.

In a sense this paper is simply testing Hagmann's hypothesis, through whatever evidence is available, now including the New York recorder. We need to investigate all means for determining roll speed, if only as an exercise in refutation.

Welte's test rolls and pneumatic playback

Test rolls were made by Welte with instructions for regulating the speed of piano and organ players. These still exist and can be applied by a skilled person, although not always reliably, partly because of the wind-motor. A handful of organ test rolls have survived at Seewen and were used to set the tempo lever to its present position. They do not always play accurately. Scans of speed-test rolls cannot easily be used through a computer: apart from other reasons they require visual checks. The result of manual adjustment with test rolls at Seewen reveals a serious anomaly, hinting at a system error responsible for the 20 % speed differences discovered by Hagmann.

The use of test rolls has thus become impractical at Seewen since scanning and digitizing was adopted as the main means of playback. Since 2007 the question of tempo and roll-speed for pneumatic playback has not been a major issue and the use of test rolls unnecessary for normal operations.

A definitive figure is nevertheless needed for computer playback so that the tempo of performances is correct.

The following have therefore been taken into account:

- Direct measurements of two still-existing organ roll transports
- Hearsay, trade talk, musical and technical observation
- Timings of recordings made from identical rolls played on other organs
- Comparisons between piano-converted-to-*Philharmonie* rolls and their originals
- Timings marked on the roll-boxes or lead-ins
- Documentation – a statement by Frau Bockisch
- The New York recorder
- Appendix: The "Tempo langsam einstellen" rolls

Position	Minutes	rev/min	m/min*	%	cf. 3m/min %
"langsam"	5.03	9.94	2.19	94	-27
"mittel"	4.73	10.58	2.33	100	-22
"schnell"	3.90	12.82	2.82	121	-6

position = setting of the speed lever on its scale
minutes = time required for 50 revolutions (converted to a decimal)
rev/min = 50÷minutes
metres/min = 60÷1000 x π x rev/min (* start 70 mm circumference, paper pre-wound at start, no allowance made for increases due to increasing diameter effects)
% = difference between *langsam* and *schnell* settings with *mittel* taken as 100 %
the "cf. 3 m/min %" column gives comparisons with 3 metres/minute
(Note: the lever appears to be "running off the curve" with only 6 % difference between slow and middle, but a 21 % difference between middle and fast).

Direct measurements of still-existing roll transports

At Seewen, tests were run in August 2012. The take-up spool was investigated by Dominik Hennig and the author in three ways: the time it took to make a total of 50 revolutions was noted with the speed lever set in its slowest, middle and fastest positions.

The roll transport on the Welte organ at Schloss Meggen (Luzern, Switzerland) was carefully restored in 1987 and is still in top condition. It measures 3.05 metres over the first minute with its speed lever centred.[10] The differences here are too wide to reconcile – Seewen clearly runs significantly slower than Meggen, endorsing Hagmann's approximation of "about 20 %".

Hearsay, trade talk, musical and technical observation

Nelson Barden has long had to deal with imprecision in organ roll-speeds. He relayed on some information gleaned from Lloyd M. Davey, a former (US) Welte technician: when asked at what speed the take-up spool rotated, Davey said: "13.5 revolutions a minute was about right". That equates to a little over 2.97 metres/minute at roll start. All take-up spools on US and European player-organs, and the New York recorder now at Seewen, have a diameter of at least 6.925 cms – say 7 cms with a roll mounted ready to play. Barden takes pains to point out that Davey was not quoting a known factory setting, just offering a subjective view on "a good speed, taking everything into account".[11] A similar approximation is a figure of "13" given by Merv Fulton of California, USA.[12]

What can also help here are technical limitations of the Welte *Philharmonie*, in particular the point at which correct roll-speed is exceeded and the system breaks down. When a roll speed of 3 metres/minute is exceeded at Seewen, very fast action movements become unstable.[13] Examples of this are Hérold's Zampa Overture (W236) where the repetition rate is extended to this limit, or Karl Mathaei's ornamentation in Scheidt's *Passamezzo* (W2059). These push every component in the Welte system to its limit.[14] More than 3 metres/minute causes serious breakdowns in pieces such as these (e.g. non-repeating notes, smudged trills).

Timings from identical rolls played on other organs

Comparison with the Tunbridge Wells *Philharmonie* may be essayed using timings on CDs made following the 2003–6 restoration by Mander and Pilmer.[15] The following table gives a comparison of the running lengths on their CD of two rolls that are also held at Seewen. In addition an orchestrion roll recorded there exists at Seewen, transferred to the *Philharmonie* 150-note standard: Wagner's "March from Tannhäuser" (W638). This assumes proper adjustment of roll-speed, that the operator did not change the lever from its calibrated "middle" position, and that the *Philharmonie* version is an exact transcription of the Orchestrion roll:[16]

In two out of three cases Tunbridge Wells runs faster than Seewen's 3 metres/minute and in one, 13 % slower, an inconsistency range of 26 %. Apart from wind-motor problems, perhaps W1251 was made to run slowly? It is a fast piece and possibly notes were not repeating properly or sounding at

Welte Roll #	Composer	Organist	Title	Seewen (scans)	Tunbridge Wells	TW cf. 3 m/min %
1251	Saint-Saëns	Lemare	Danse Macabre	6′11″	7′00″	-13
1268	Offenbach	Lemare	Barcarolle	3′09″	2′37″	+17
638	Wagner	hand-made	March Tannhäuser	7′02″	6′09″	+13

all when played at full speed on the day of recording. It has already been the subject of some query because Welte seem to have issued it in different forms. The use of the Harfe stop appears to be different in all three copies that can currently be tested.[17]

In the late 20th century Nelson Barden made a number of CDs of Lemare's playing. Neither organ nor player mechanism were entirely Welte *Philharmonie* originals and some work was done on the rolls to make the pedal play without Welte's expedient of advancing it. The speed at roll start seems to have been slightly faster than 3 metres/minute.

Nevertheless, some useful comparisons can be made e.g. from a recording of the Bach d minor Toccata and Fugue (BWV565) played by Lemare on W1163: a Seewen recording; one by Barden (who relates that he had difficulty making the rolls run slowly enough); and a *Philharmonie* I–II roll (converted down from 150-holes in 1920) on the Bruchsal instrument.

Welte Roll #	Timing	+/-%
1163 Seewen	8′45″	0 (reference)
1163 Barden	7′47″	+11
1163 Bruchsal	7′57″	+10

Some years ago a CD box-set of French organists appeared[18]. The Linz am Rhein organ, later in USA, now in Fribourg/Switzerland, was used. The CDs included some of Gigout's rolls also found in Seewen. (Seewen = 3 metres/minute at roll start).

Obviously the excessive range of differences for exactly the same rolls – from 1.5 to 33.1% – points to serious inconsistencies.

Comparison of three recordings from around the 1980s by Swedish Radio (SR), and 2 LP recordings under the titles of "Unvergänglich-Unvergessen" (UU) and "Reger plays Reger" (RR) is also instructive[19]. Hagmann's "20% slower" is well exceeded by some of these, although a few are faster. Both operator intervention and drive-motor errors must lie at the root of the problem. It is not just consistency of speed: e.g. the Linz am Rhein organ is smaller, its Harfe stop was switched out for a recording of Gigout playing his own b minor Toccata[20], and the Tunbridge Wells CDs were made without any swell expression.

Work	Performer	Seewen Roll scan	SR	% slower	UU	% slower	RR	% slower
Reger Benedictus	Reger	5′24″	6′57″	22	5′02″	-7	5′34″	3
Reger Melodia	Reger	6′48″	8′23″	19	6′13″	-9	7′10″	5
Reger Moment musicale	Reger	6′06″	7′41″	21	5′24″	-13	5′49″	-5
Reger Wer nur den l. Gott	Reger	2′24″	2′59″	20	2′28″	3	2′32″	5
Reger Lobt Gott	Reger	1′24″	2′06″	33	1′32″	9	1′39“	15
Reger O wie Selig	Reger	1′35″	2′59″	47	1′39″	4	1′58″	19
Reger O Welt ich muss	Reger	3′18″	4′02″	18	2′59″	-11		
Reger Basso ostinato	Reger	3′30″	4′11″	16			3′44″	6
Reger Romanze op. 69/8	Reger	4′30″	4′18″	-5				
Lemare Andantino	Lemare	4′54″	7′01″	30				
Lemare Improvisation	Lemare	8′29″	1′06″	24				
Sjögren Drei Legenden	Grosse	6′48″	7′33″	10				

Work (organist Gigout)	Welte Nr.	Timing Linz/Rhein	Timing Seewen	% difference Linz/Rhein
Grand choeur dialogué	1085	5′42″	4′17″	-33.1
Cantilène en la	1602	4′33v	4′15″	-7.1
Toccata in b minor	1084	3′21″	3′18″	-1.5
Boëllmann Communion	1591	3′08″	2′48″	-11.9

Welte Philharmonie Roll Number	m/sec	CD %
W 75		
Brahms/Nikisch – Hungarian Dance 5		
Philharmonie roll	2´24˝	
Piano CD	2´17˝	+ 5.1
W 76		
Brahms/Nikisch – Hungarian Dance 6		
Philharmonie roll	3´05˝	
Piano CD	3´12˝	- 3.6
W 355		
Mendelssohn/Friedheim – Lied ohne Worte		
Philharmonie roll	3´14˝	
Piano CD	3´27˝	- 6.3
W 384		
Lanner/Schnabel – Altwiener Walzer		
Philharmonie roll	6´04˝	
Piano CD	5´51˝	+ 3.7
W 653		
Wagner/Mottl – Parsifal Good Friday Magic		
Philharmonie roll	9´39˝	
Piano CD	10´24˝	- 7.2
W 654		
Wagner/Mottl – Lohengrin-Intro		
Philharmonie roll	10´14˝	
Piano CD	10´22˝	- 1.3
W 656		
Wagner/Mottl – Lohengrin, Elsa's Traum		
Philharmonie roll	6´57˝	
Piano CD	7´49˝	- 11.1
W 658		
Wagner/Mottl – Meistersinger Am stillen Herd		
Philharmonie roll	5´06˝	
Piano CD	5´25˝	- 5.8
W 800		
Saint-Saëns/Saint-Saëns – Samson und Dalila Finale		
Philharmonie roll	5´07˝	
Piano CD	4´56˝	+ 3.7

Comparisons: the piano-converted-to-Philharmonie rolls

In the early days of the *Philharmonie*, when artist-recorded performances were scarce, Welte took a number of existing piano rolls and converted them to 150-hole rolls for organ.[21] Hagmann quotes some by Nikisch, Paderewski and Mottl to endorse his figure of "about 20 % too slow". The playback roll transport at Seewen now runs (middle position) at an unusual 2.33 metres/minute at roll start; Hagmann's 20 % increases this to at least 2.8.

In the course of these investigations, Hans Schmitz precisely adjusted the speed of a Welte player-piano standing alongside the Seewen organ. A piano roll which had been transferred to *Philharmonie* format was selected (W1092 Lucien Wurmser playing Mozart's *Pastorale Variée*). Both were played back and timed. The two performances came out within 6 seconds of each other, fringing around 6'30".

This approach, when later extended by Hans Schmitz and the author in early 2013, proved less reliable. Schmitz kindly provided CD timings of some piano performances which had been transferred under his supervision (*see table on the left*).

Although this method had worked well for Hagmann and our first test, it did not stand up in the final analysis.

Using recording comparisons as an investigative method is thus clearly open to serious flaws because of the many critical factors which are now out of our control. The most elusive problems are wind-motor unreliability and operator intervention. Welte recorded accurately but made playback too freely subject to mechanical problems and human interference.

Timings marked on the roll-boxes or lead-ins

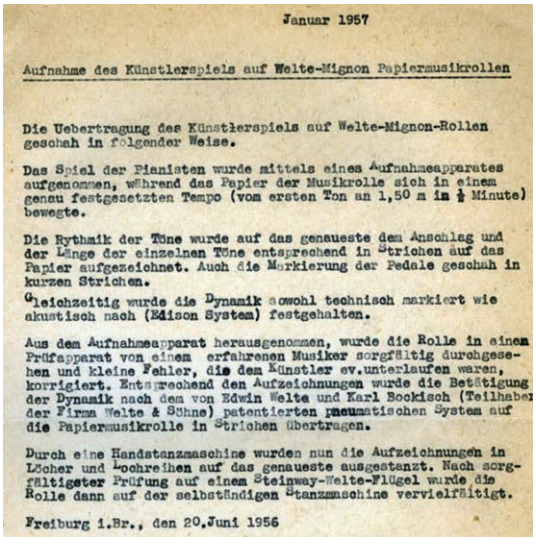
At least 83 roll lead-ins or boxes at Seewen show an estimation of the roll's playing time. These are noted in a variety of manners. Few appear to be official factory figures; many are just pencilled in. The following table gives values for a representative 62 of them.

The deviation between marked and actual timings here is alarming. None except some duplicate copies have identical timings. W1380 is marked at over 5 minutes longer than its actual playing time of 4'53". W1763 is given at almost triple its playing time of 6'44". Some timings look like they have been made on the Seewen organ when it was running 20 % too slowly.

This method is thus clearly totally unreliable.

Documentation – the letter attributed to Frau Bockisch

An unsigned document originating from within the Welte family bears two dates: 20th June 1956 and January 1957[22]. It gives a description of the recording process for piano rolls. A figure of 1.5 metres in 30 seconds is given as roll speed. Some deny the credibility of this letter, but it is well-expressed, in good clear German, has no grammatical errors, reveals "insider knowledge" and offers as good a source as Lloyd Davey and Merv Fulton, closely corroborating their statements.



Januar 1957

Aufnahme des Künstlerspiels auf Welte-Mignon Papiermusikrollen

Die Uebertragung des Künstlerspiels auf Welte-Mignon-Rollen geschah in folgender Weise.

Das Spiel der Pianisten wurde mittels eines Aufnahmeapparates aufgenommen, während das Papier der Musikrolle sich in einem genau festgesetzten Tempo (vom ersten Ton an 1,50 m in ½ Minute) bewegte.

Die Rythmik der Töne wurde auf das genaueste dem Anschlag und der Länge der einzelnen Töne entsprechend in Strichen auf das Papier aufgezeichnet. Auch die Markierung der Pedale geschah in kurzen Strichen.

Gleichzeitig wurde die Dynamik sowohl technisch markiert wie akustisch nach (Edison System) festgehalten.

Aus dem Aufnahmeapparat herausgenommen, wurde die Rolle in einem Prüfapparat von einem erfahrenen Musiker sorgfältig durchgesehen und kleine Fehler, die dem Künstler ev.unterlaufen waren, korrigiert. Entsprechend den Aufzeichnungen wurde die Betätigung der Dynamik nach dem von Edwin Welte und Karl Bockisch (Teilhaber der Firma Welte & Söhne) patentierten pneumatischen System auf die Papiermusikrolle in Strichen übertragen.

Durch eine Handstanzmaschine wurden nun die Aufzeichnungen in Löcher und Lochreihen auf das genaueste ausgestenzt. Nach sorgfältigster Prüfung auf einem Steinway-Welte-Flügel wurde die Rolle dann auf der selbständigen Stanzmaschine vervielfältigt.

Freiburg i.Br., den 20.Juni 1956

Fig. 3 – Speed lever on a Philharmonie

W #	Roll	Noted	%Roll/noted	Marking
41	13′07″	14′10″	93	14 min 10 secs
42	15′57″	14′30″	110	14 ½ minutes
53	2′53″	2′40″	108	2′40″ minutes written on box
536	11′09″	11′15″	99	11 ¼ minutes written on box
544	9′09″	7′00″	131	7 minutes written on roll
569	8′44″	11′00″	79	11 minutes written on box
591	11′41″	11′20″	103	11′20″ written on roll
682	9′29″	10′20″	92	10′20″ written on roll
751	9′27″	10′00″	95	10 mins (?) written on box
751	9′22″	10′00″	94	10 mins (?) written on box
761	3′57″	4′10″	95	4′10″ written on box
768	10′05″	9′55″	102	9′55″ written on box
791	4′57″	4′00″	124	4 mins written on roll
791	5′00″	4′00″	125	4 mins written on roll
791	4′44″	4′00″	118	4 mins written on roll
955	9′29″	10′10″	93	10′10″ on box
956	8′37″	8′30v	101	8 and a half minutes
956	8′37″	8′30″	101	8 and a half minutes
1001	10′04″	12′00″	84	Circa 12 minutes
1001	10′13″	12′00″	85	Circa 12 minutes
1018	6′04″	7′40″	79	7′40″ written on box
1042	6′57″	8′00″	87	8′ on box
1098	5′49″	5′30″	106	5 ½ mins on box
1190	7′05″	6′50″	104	7–8 mins (deleted) 6′50″ on box
1247	12′48″	12′00″	107	12 minutes written on box
1252	5′29″	6′25″	85	6′25″ on box
2129	5′26v	5′00″	109	5 mins written on the roll
1270	9′29″	10′20″	92	10′20″ on both roll and box
1306	4′50″	4′45″	102	4′45″ written on box
1308	7′04″	7′10″	99	7′10″ written on box
1340	6′48″	7′00″	97	7 mins on box
1349	14′48″	10′20″	143	10′20″ on box
1380	4′53″	10′00″	49	Circa 10 mins on box
1400	8′11″	7′20″	112	7′20″ written on box
1400	8′10″	7′20″	111	7′20″ written on box
1429	10′00″	13′00″	77	Box = ca 13 minutes (written)
1444	7′58″	7′00″	114	7 mins on box
1448	8′18″	9′00″	92	9 mins on box
1462	16′34″	20′00″	83	20 mins (? unclear) written on box
1637	5′45″	6′30″	88	6′30″ written on box
1763	6′36″	6′40″	99	Roll = 18min, 20 Metres
1763	6′44″	18′00″	37	18 mins written on roll
1820	8′02″	7′00″	115	7 mins written on box
1871	5′14″	5′00″	105	5 mins on roll lead-in
1885	17′33″	16′00″	110	16 mins written on box
1926	6′04″	7′30″	81	7–8 mins written on box
1938	7′31″	7′25″	101	7′25″ written on box
1939	4′02″	3′00″	134	3 mins printed on roll
1991	10′33″	10′40″	99	10′40″ written on box
1992	6′53″	7′00″	98	7 mins written on box
2058	9′55″	11′25″	87	11′25″ written on box

W	#Roll	Noted	%Roll/noted	Marking
2067	8′25″	8′30″	99	8 ½ mins written on roll lead-in
2069	3′25″	3′00″	114	3 mins on roll lead-in
2079	4′33″	4′00″	114	4 mins written on the roll
2080	2′48v	3′00″	93	3 mins on roll lead-in
2080	2′45″	3′00″	92	3 mins on roll lead-in
2094	12′13″	12′00″	102	12 mins written on roll lead-in
2125	4′51″	5′00″	97	5 mins written on roll
2129	5′27″	5′00″	109	5 mins written on the roll
2129	5′26″	6′25″	85	6′25″ on box
2135	5′30″	5′00″	110 5	minutes written on lead-in
2161	5′32″	7′30″	74	7–8 mins written on box
			99	Average
			143 Maximum – Maximum deviation faster (44 %)	
			37 Minimum – Maximum deviation slower (268 %)	

It is necessary here to assume that piano and organ rolls were recorded at the same speed. Only very few were not (see later). However, coupled with the analyses by Hans Schmitz of the organ recorder,[23] and remembering that Welte pioneered their organ recording directly out of the "Mignon" piano system, we have a valuable conjunction. The recorder can mark up to 175 lines on a roll, strongly suggesting it was intended for wider use than just the *Philharmonie's* 150.

In March 2013 Matthias Schiemann of Flensburg noticed that the bar supporting the marker-wheel mechanisms had "Piano B" and "Piano T" engraved at either end, flanking the central 150-line segment. This had hitherto gone unnoticed, partly because it had been covered with corrosion. Quite independently at about the same time, Nelson Barden noticed in an old photo that the flange on the take-up spool was set to a narrower width than for a typical Philharmonie roll. This spool freely allows settings for widths inside and outside the parameters of the *Philharmonie* "150". So, was this machine also used for piano recordings?

If it was, then taking account of its modus operandi, the speed of recordings for organ was most likely the same as that for piano.[24] The figure of 3 metres/minute for piano roll recordings, and the same figure being derived *inter alia* from the New York recorder detailed below, however, argue strong cases.

The New York recorder: final arbiter?

Welte's New York recorder found its way to Seewen in the late 20th century. Much of its mechanism remains intact, restored for the exhibition which opened in 2011. There are two means at our disposal for calculating the roll-speeds for which it was designed and used:

— known motor speeds and gearing
— observing the running parameters of relevant components.

Early in 2011 Hans Schmitz undertook a detailed analysis and published his description of it.[25] He calculated that, since the electric drive motor was rated at 1150 rev/min and the gearing was 86-to-1, the spool (assumed diameter 6.925 cms) rotated at 13.37 rev/minute. Allowing for some wound-on paper (7 cms) he reckoned on 2.941 metres/minute. However, this involves a small misunderstanding of constant speed motor characteristics[26], and many lead-ins need more than a layer or two before the music starts. In a check during April 2014 organ spool diameters were measured at Seewen as 6.950 cms,

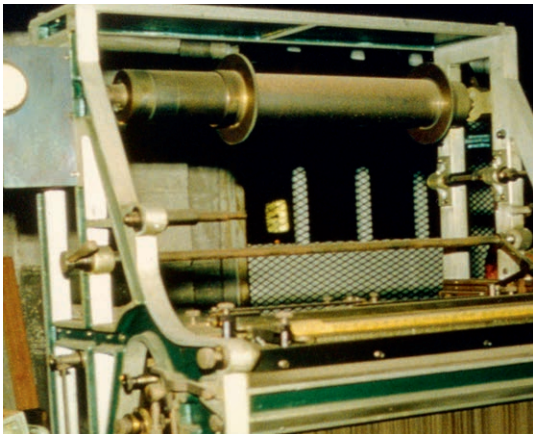


Fig. 4 – Adjustable flange set narrow

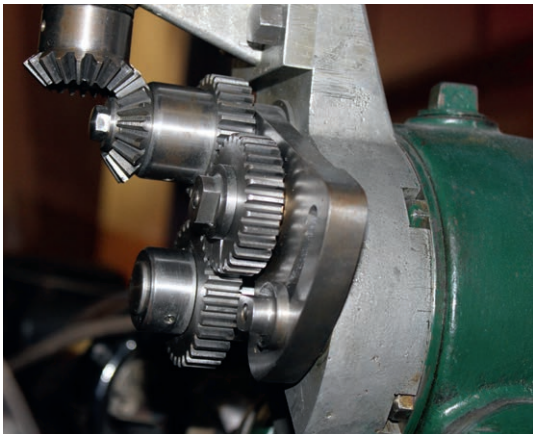


Fig. 5 – 86:1 worm drive (green housing): further ratios available from cogwheel sets

and paper thickness 0.09 mm, with typically about 5 revolutions occurring before music start.

The second approach is by means of the speed indicator. This has a pointer driven by a centrifugal governor acting "in reverse". The read-out has a black-printed scale around its arc of travel. The middle of this is at the "12-o'clock" position. There are also two pencilled-in red markings situated at about the 10- and 11-o'clock positions. The 12-o'clock position was duplicated on the glass cover with a black marker pen. No indication now exists of what any of these represented.

Gears with interchangeable cogs can further affect the 86-to-1 worm drive ratio. These are attached on its spool side; 32-, 30- and 28-toothed versions survive. David Krall indicates similar gearing exists on the master-reader now in his possession. The gears and worm drives have "Boston" stamped on them.[27] All recorder cogs were investigated but the most likely original gearing is 1:1 for *Philharmonie* recordings. Others seem unrelated and only 1:1 aligns with the available evidence; e.g. Frau Bockisch's letter, Hagmann's hypothesis, measurements at Seewen and Meggen and the fact that virtually 100 % of sales rolls are 1:1 copies of their masters.

The centrifugal device driving the pointer has three arms, each with a small metal weight which can be adjusted by screwing it in or out and then locking them in place by grub screws. At too high a speed they strike the adjacent metal housing. With the dial pointing to the top black marker, strikes do not occur at a roll start of 3 metres/minute, but they quickly happen if the spool is revolved any faster. As with action repetition rates, such limits define operating maximums. Three settings of these counterweights were investigated: (all three) in mid-position, fully wound out and fully wound in.

Fig. 6 – The two red markers

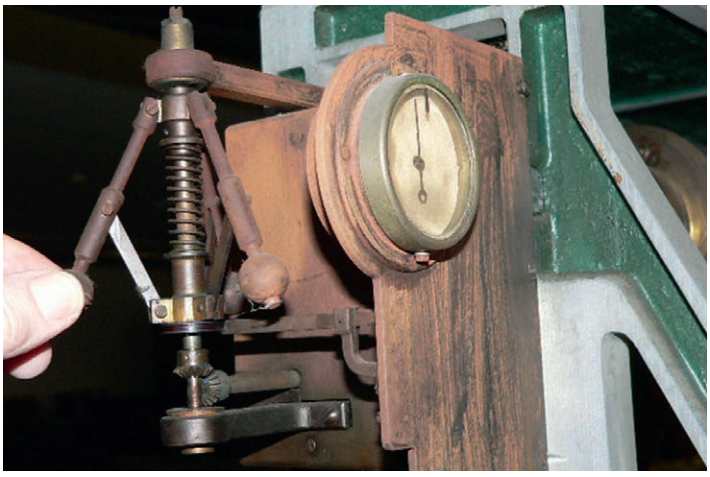


Fig. 7 – Showing top black marker on the glass

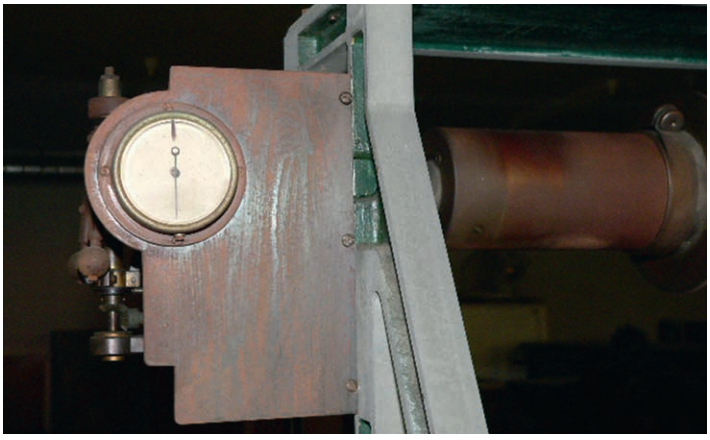


Fig. 8 – With top black marker visible

The revolutions of the take-up spool were measured for different dial positions – 12-o'clock black marking, 10- and 11-o'clock red markings – and all converted into metres/minute at roll start. A now non-functioning original motor was not crucial to these experiments so a modern electric motor was connected and the whole system was operated through a controller[28] that allowed speed to be varied.

Merv Fulton regards the upper black marker as the one for (Welte) organ recordings. The significance of the red markings is unclear to him[29]. With motor and controller connected, the dial pointer was brought to each of the three markings and two values extracted: empty spool rotation (converted to metres/minute) and the length of roll travel in 1 minute when loaded with paper (which starts to take account of increasing diameters).

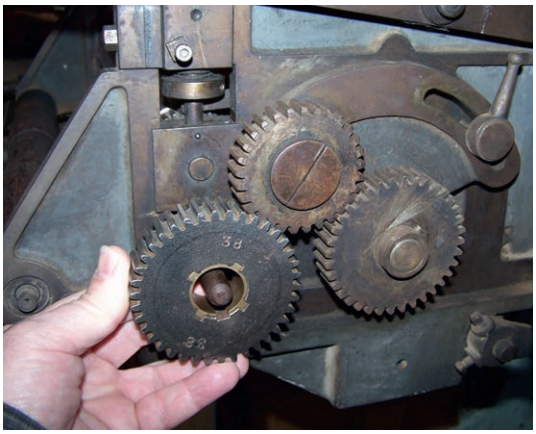


Fig. 9 – Interchangeable copy-machine gearing photo courtesy of David Krall

Fig. 10 – Two of the New York (Seewen) recorder's interchangeable cogwheels

Governor weights in mid-position		min	m/min	cf.3 m/min %
Highest black marking test 1				
Revolutions total, spool empty	24.00	1′42″	3.07	+2.4
With paper; travel in metres	3.05	1′00″	3.05	+1.7
Highest black marking test 2				
Revolutions total, spool empty	24.00	1′41″	3.10	+3.4
With paper; travel in metres	3.05	1′00″	3.05	+1.7
Highest red marking				
Revolutions total, spool empty	24.00	1′44″	3.01	+0.4
With paper; travel in metres	3.05	1′00″	3.05	+1.7
Repeated				
Revolutions total, spool empty	24.00	1′45″	2.98	-0.5
With paper; travel in metres	2.94 1	′00″	2.94	-2.0
Lowest red marking				
Revolutions total, spool empty	24.00	1′52″	2.80	-6.8
With paper; travel in metres	2.75	1′00″	2.75	-8.3
Governor weights fully retracted				
Highest red marking				
Revolutions total, spool empty	24.00	1′41″	3.10	+3.4
With paper; travel in metres	3.05	1′00″	3.05	+1.7
Lowest red marking				
Revolutions total, spool empty	24.00	1′50″	2.85	-5.1
With paper; travel in metres	2.78	1′00″	2.78	-7.3
Governor weights fully extended				
Highest red marking				
Revolutions total, spool empty	24.00	1′46″	2.96	-1.5
With paper; travel in metres	2.91	1′00″	2.91	-3.0
Lowest red marking				
Revolutions total, spool empty	24.00	1′54″	2.75	-8.4
With paper; travel in metres	2.69	1′00″	2.69	-10.3

With weights fully retracted or extended no dramatically variant readings are noted between either the top red marking or top black marking with paper loaded and governor weights in mid-position. This generally gave a +/- 2 % speed variation on 3 metres/minute.

Hans Schmitz returned to do additional checks in September 2013, extending investigations to the effects of increasing diameters. He reports his results elsewhere. The most consistent values came from the black centre marking (metres/minute roll travel; 1 minute test):

	Schmitz	Rumsey	Average
Black mid-point marker	3.05	3.05	3.05
Upper red marking	2.97	2.94	2.955
Lower red marking	2.87	2.75	2.81

The pointer sometimes flickered alarmingly at lower speeds, making precision difficult when aligning it to the red markers. This might relate to Barden's problems in getting a player mechanism to run slowly enough.[30] It may also account for some inconsistencies. The above readings were taken with the weights in their mid-positions[31]. 3.05 includes an expected small initial component of diameter increase.

The red markings seem to bear no relationship to other known roll speeds for either Welte's piano or organ rolls, nor do they appear to have any bearing on the "Tempo langsam einstellen" rolls (*see appendix*). They possibly belong to later owners of the machine, such as Kimball, in non-Welte-related usage of it. Nor is this explained by the surviving cog-

wheels, although a few of the Seewen Masters appear to have information noted on them which could be targets for future research here[32].

Late 20th century observations by Nelson Barden[33] showed that most musicians could experience a speed variation in roll playback of up to 6 % before they perceived tempo change. Welte sometimes operated very close to whatever they could get away with: their bass/treble dynamic system for pianos was clever, but a compromise[34]. The firm generally seems to have operated within tolerances of about 2 % – well within Barden's 6 % minimum needed for perception.

On 23rd February 2015 Dominik Hennig, Nicola Cittadin and the author conducted a number of tests and found that, with all of the recorder's relevant systems adjusted to their mid-positions – centrifugal weights, loaded with paper, the drive motor brought by the operator up to a speed where the dial pointer was at 12 o'clock – the paper moved at 3 metres/minute.

Appendix

The "Tempo langsam einstellen" rolls

A few of the commercially available organ rolls carry the instruction "Tempo langsam einstellen" ("set the roll speed to slow"). These are "long-play" rolls apparently intended for works of around 15- to over 20-minutes' duration. Very few rolls of this "long-play" type exist. The need is unclear: almost all rolls of commensurate duration ran at standard speed anyway. Even so, were the two red markings anything to do with the "Tempo langsam einstellen" rolls?

Evidence from the masters strongly hints at these being recorded at full speed, then transformed later, possibly in a copying process using other machines. As noted above, David Krall reports associated gearing that may have facilitated this[35].

Prima facie this seems not to be the case for the gear-set of the New York recorder. The speed difference between upper and lower red markers is at best only 5 %, which is far from the known values of 10 % and 20 % from the one currently useful "long-play" roll which exists as both master and copy from which this might be assessed[36]. Nor would 5 % have been a very useful saving – allowing only an additional 1 minute recording on a 20 minute roll.

Only four "long-play" titles are found in the Seewen collection that are represented by both master and copy[37]:

Roll	Composer	Work	Duration	Notes
752 (Master)	Boëllmann	Suite Gothique	18′08	ca. 10 % difference, but Welte editing is evident here and in other shortened versions – the roll does not play. The validity of these figures is currently questionable
752 (Copy)	Boëllmann	Suite Gothique	16′24″	
1217 (Master)	Wagner	Siegfried Idyll, arrang. Lemare	18′58″	copy roll is damaged and so far unable to be scanned
1217 (Copy)	Wagner	Siegfried Idyll,	n/a	
1462 (Master)	Handel	Concerto	19′52″	around 20 % difference[38]
1462 (Copy)	Handel	Concerto	16′43″	
2085 (Master)	Gabriel Marie	La Cinquantaine – Air dans la style ancien	3′39″	same duration?
2085 (Copy)	Gabriel Marie	La Cinquantaine – Air dans la style ancien	3′39″	

W2085 is a total mystery: why did a roll of less than 4 minutes ever need a "long-play" configuration? Factory error? Wrong gearing used? The only useful and seemingly reliable information is from W1462: 20 %. The master plays at a convincingly good tempo, the copy gives a clear "fast forward" effect. Both rolls currently have technical problems, but none that affect questions of speed. The copy roll, which bears the "Tempo langsam einstellen" instruction, needs slowing to the point that it also plays at 19'52". A reduction in speed of 19.92 % achieves this – a speed lever reset from "normal" to "slow"?

There seems to be no valid connection between any of these rolls and the two red markings on the dial of the New York recorder. Indeed a suspicion could be entertained, given the lack of necessity to even make "long play" rolls, and the apparently highly irrational application of this procedure to a roll of less than 4 minutes' duration, that the instruction might simply have been a compensation for a mistake in gearing during roll-copying.

Denis Hall recently wrote that, in connection with piano rolls, Welte opted for a standard speed of "70" – which he interprets as an imperial measurement of 7 feet per minute[39]. The New York recorder would have to move the paper at 2.13 metres/minute, well below either the lower red mark (2.8) or the nearest "gearing solution" available (2.76). None of the markings gives any logical read-out that could correspond to 7 feet per minute. Nor do they seem to stand in useful relation to anything we are investigating regarding "long-play" rolls. To all intents and purposes they seem not to be Welte-related and may have been put there by later owners for their own purposes.

Conclusion

These results show that human intervention, amongst other factors, allowed no fully assured control over the playback functions of Welte's organs or pianos once they left the factory and became subject to playback using the wind-motor. Yet it is clear that, for recording, the firm made a highly accurate system.

A 3 metres/minute roll speed at start of play endorses Hagmann's analysis of 1984, agrees with the functions of the New York recorder and is within credible tolerances of all trustworthy reports. Hagmann's view was that no stable and accurate speed could be assured in the process of recording and playback. However, he did not have access to the New York recorder which has no pneumatic motor, rather a far more reliable electric motor working through a 1:86 gearing. With three motors driving the recorder, having only one dedicated to roll transport was good engineering: ample power, adjustable speed, effective gearing ratio and unique dedication to the task.

From 2009 onwards the roll-scanning and digitizing processes at Seewen were also driven electrically, with checks and balances enabling a precision undreamt of using Welte's pneumatic motors. With computer playback no Welte pneumatic motor is now found in the chain from recording through playback.

1 Alfred Hollins in: *A Blind Musician Looks Back*. Quoted in: Museum für Musikautomaten (Hrsg.), *Wie von Geisterhand aus Seewen in die Welt 100 Jahre Welte-Philharmonie-Orgel,* Booklet to the Seewen 2011 Exhibition ISBN 978-3-9523397 p75.

2 As determined from master rolls by Dominik Hennig, reported elsewhere in this publication. Aeolian used only 4 stages according to information supplied by Nelson Barden in 2012; it was generally deemed sufficient.

3 See the Seewen Exhibition Booklet 2011 op.cit. p78. This machine is now owned by David Krall (USA).

4 Peter Hagmann: *Das Welte-Mignon-Klavier, die Welte-Philharmonie-Orgel und die Anfänge der Reproduktion von Musik*, Bern 1984 pp85 – 86.

5 Pianist Manuel Bärtsch presented this problem in relation to Mahler in a 13th February 2014 Swiss TV interview: *http://www.srf.ch/player/tv/videoembed?id=48488bad-ef19-4767-8968-ec5618a19bf1&width=640&height=360&mode=embed&autoplay=true* (in Swiss German, abgerufen am 28.9. 2017).

6 The Debrunner scanner uses a device which takes linear measures of paper travel, hence the need for diameter compensation.

7 This was the bane of owners in Europe and North America who replaced their Welte wind-motors with electric motors. Resistors, potentiometers etc. were brought in to try and make them run according to Welte motor characteristics.

8 Communicated in e-mails and by telephone 2009 – 2012.

9 Hans Schmitz made some tests on 11th September 2012. The Welte wind-motor was used. It showed a roll-speed of 2.86 metres/minute at the start of play, becoming 3.66 metres/minute after 6 minutes had elapsed.

10 As established by Marco Brandazza and Dominik Hennig on my behalf using the same test procedures that Hennig and myself had adopted for Seewen. I extend my gratitude to them for carrying out this work.

11 In a Skype communication with the author, February 2013.

12 From a typed manuscript detailing Fulton's experiences as an owner of the New York recorder (delivered to Seewen in March 2013).

13 The Seewen organ was left in the 2007 restoration essentially as Welte had built or rebuilt it. Replacing the original magnets and electro-pneumatic components had to be avoided for heritage reasons. The computer now feeds non-intrusively into the final stage of the electric action.

14 See *The Britannic Organ* Volume 1, CD 1, Track 7, and Volume 7, CD 2, Track 4.

15 *Welte restored* released 2011 by the Royal Academy of Music and Canterbury Christ Church University. RAM 043 (CTRS 1032).

16 A number of piano and orchestrion rolls were converted by Welte in the early days of the *Philharmonie* when artist-recorded rolls were scarce. All evidence so far shows that Hagmann was correct: all Welte seems to have done is to transfer the perforations, 1:1, then create registrations and extract organ pedal parts from the bass line. Few exceptions exist (e.g. W482 was extended from 9´43´´ to 10´28´´).

17 Seewen has a master which plays back poorly. Running time is not affected. It has since been edited carefully, based on the Seewen master, and released on CD late in 2014 (*The Britannic Organ* Volume 9).

18 EMI 5 CD set 7243 5 74866 2 0 CD 2

19 I am indebted to radio producer Curt Carlsson (Sweden) and organist Marcel Punt (Finnland) for providing details of these recordings.

20 The masters show, *prima facie*, that the Harfe was indeed the performer's decision. (*The Britannic Organ* Volume 4).

21 Hagmann (op.cit. p86) goes into this question with the assumption that rolls transferred from piano to organ should have the same playing duration.

22 My thanks to Gerhard Dangel, Freiburg Augustiner Museum, for passing on a copy of this document.

23 In: Museum für Musikautomaten (Hrsg.), *Wie von Geisterhand – Aus Seewen in die Welt,* Seewen 2011, pp116 – 125.

24 An announcement of this find was published by Christoph E. Hänggi in: Das Mechanische Musikinstrument, No. 116, April 2013 (p. 56). This poses many so far unanswered questions and requires much further investigation, including reconciling the sizes of piano roll copies with their masters as well as the hole widths of piano compared to organ roll perforations, and just how wide a piano master needed to be to have the extra "Piano B" and "Piano T" markers record on them.

25 op.cit pp116ff.

26 op. cit p124. One common assumption – that a constant speed motor of the kind driving the New York recorder's roll transport can only rotate at one speed – is incorrect. Higher speeds are easily achievable and finely adjustable by placing a field rheostat in the circuit (lower speeds are not impossible, but far more complicated to achieve). Welte's technology here seems clear: provide a motor which rotates slightly slower than needed, then allow the operator to make fine adjustments upwards using a rheostat and aligning a pointer to a mark on a dial. Whether the rheostat now so conveniently placed in this manner was the one used is currently an open question, but Welte provided exactly the same system for similar purposes elsewhere (e.g. in some Vorsetzers). It is thus the dial indicator, not the rated minimum motor speed that is crucial here. All evidence and logic so far points to a "12 o'clock" setting. The adjustment of the read-out for correct speed, whether at "12 o'clock" or not, is made using the 3 counterweights of the centrifugal device. Our measurements indicate adjustment up to around 4 % was possible. Once again a comfortable mid-value here of about

+/-2 % can give 3 metres per minute assuming correct motor speeds (unknown, but more than the 1150 rev/min on the motor's nameplate). Detail of how to adjust these counterweights does not survive other than indirectly in Frau Bockisch's letter and measurements of some existing pneumatic roll players mentioned elsewhere in this article. (My thanks to Andrew Baghurst of Port Elliot, South Australia, for his advice on the operation of constant speed DC motors – e-mail of 26th November 2014.)

27 Nelson Barden identifies this as The Boston Gear Works, the world's largest manufacturer of standard stock gears, started in Boston, Massachusetts by George B. Grant in 1877 (now part of Incom International, Inc.). Caution needs to be applied. This gearing could also have been on the Freiburg recorder, or possibly not. After some recent informal analyses, with David Krall in Chicago and Nelson Barden in Boston, amongst others, it seems likely now that the New York recorder was of US manufacture.

28 Hitachi SJ 200.

29 Information relayed by Nelson Barden, 7th March, 2013 (video conference).

30 An initial series of the author's own tests had to be aborted due to a mechanical breakage which occurred in the gearing. These tests were showing significantly slower speeds.

31 During the tests one of these little metal balls struck the plating alongside it due to overspeed, displacing its position on the arm (it was not secured by its grub-screw at the time). The effect was minimal since, even with all three weights moved, the difference was found to be only 4.8 % between the highest setting and the lowest. With only one arm of the three affected and the displacement being from mid-position it could mean an error of as little as 0.8 %. It is interesting to note the relatively small influence these centrifugal weights have around their central range of adjustment.

32 Rare references on the master rolls are found to "Rad" (plural "Räder") or variants. This could mean cogs, wheels, teeth or possibly have some other significance.
* W386 (Meyerbeer, L'Africaine): to be perforated with "140 Rad"
* W294 and 295 (Leoncavallo, Pagliacci) simply have "Räder" on their boxes
* W1874 (Reger's Wachet auf! played by Grosse) has "Achtung 31 Rad" ("Caution! 31 Rad")
* W1918 (Bortniansky, Vesper Hymn played by Mania) has "mit Räder gestanzt (perforated)"
* W1747 (Reubke played by Landmann): "Rad 32"
* W2091 (Hans Häuser, cinema roll, Meadow Lark, Foxtrot etc.) "ist mit 38 Rad gestanzt" (="is perforated with 38 Rad"?)
* W2094 (Hans Häuser, plays Heuberger): a reference to "Rd", possibly "Rad"?

33 Details verbally communicated in 2009.

34 see Hagmann op.cit., and Manuel Bärtsch "Zweifelhafte Interpretation, zweifelhafte Aufnahmesysteme? Ferruccio Busonis Aufnahme des Chopin-Nocturnes op.15/2 auf Welte Mignon-Rolle und Shellack". Universität Bern, Institut für Musikwissenschaft, Studienprogamm: Master in Research on the Arts, Matrikel-Nr.: 11-130-333 30.6.2012.

35 In a Skype session 14th March, 2014.

36 An interesting comment at the conference was that, in the experience of circles around Rex Lawson, a figure of 20 % for these "Tempo langsam einstellen" rolls has also been derived from piano rolls.

37 The Reubke 94th Psalm Sonata played by Arno Landmann also presents us with something of an enigma. Four rolls are available in Seewen:
W1746 (a master roll, copy and a production copy): from the start to the end of the first main section
W1747 (master roll, copy): first part of the first section only
W1748 (master roll, copy): from beginning – but a truncated version
Apart from serving as an indication of the various ways this lengthy piece was sometimes presented in early 20th century, the two ostensibly identical W1746 rolls play with differing durations, master 18´27´´ copy 20´49´´. No indication associated with this roll has so far been found signalling a tempo reset, so the 11 % difference was either intentionally adjusted or there were other reasons for this not now known. The only settings on the New York recorder that even vaguely approach 11 % are with the weights fully extended and applying the lower red marker. That could only mean a master roll recorded on the slow setting copied with compensation to a player roll which was to be played normally. This seems unlikely. A scenario of a lack of paper on the day of recording is also an unlikely explanation. Could there be a gearing (mistake) factor in this? A "Tempo schnell einstellen" verges on the comic and has never been seen.

38 The copy roll additionally has an unclear timing marked on its box: it might read "20 minutes".

39 The Pianola Journal, No. 22 2012, p4.

David Rumsey

ABSTRACT

The speed of Welte's organ rolls

The total lack of factory instructions, or hard evidence, about the exact speed with which Welte's organ rolls were intended to run requires investigation through other channels if this important parameter is to be used in studying roll-recorded performances. With the Welte system this goes far beyond mere questions of tempo, critical as they are for modern musicological study of performance paradigms, but also affects trills, clean note-repetitions, swell crescendos, wind-sufficiency – and, most importantly, the credibility of rolls as accurate musical or scientific representatives of the early 20th century performers who made them.

Welte made very accurate recordings with electric rather than pneumatic drive-motors. It was only in playback that these pneumatic motors were problematic.

The few leads we have to establishing accuracy are complicated by the fact that this system used constant rotation of the take-up spool as its yardstick rather than constant linear movement of the roll-paper. As the paper wound on, so the speed incrementally increased until the end of a roll was travelling at factors through 2 to well over 4 times its speed at start of play depending on the length of the piece.

In investigating this question we have a number of sources that offer information and some confusing Welte-practices of occasionally intentionally varying roll-playback speeds. However a critical examination of them soon separates the untrustworthy from the more reliable.

Formerly scholars had only wind-motor-operated devices to investigate this question. However now that the New York organ recorder has been analyzed and sufficiently reconstructed to provide highly trustworthy figures it can endorse or otherwise some of the other approaches hitherto available. This has also resulted in discovering that the Welte recording system, allied to modern scanning and computer playback, can entirely eliminate the notorious vagaries of Welte's pneumatic motors.

David Rumsey

ZUSAMMENFASSUNG

Die Geschwindigkeit der Welte-Orgelrollen

Das gänzliche Fehlen von Herstellerangaben oder konkreter Hinweise zur genauen Geschwindigkeit, mit der die Welte-Orgelrollen abgespielt werden sollten, erfordert andere Herangehensweisen, falls wir diesen wichtigen Parameter für die Untersuchung der auf Rollen gespielten Aufführungen einbeziehen wollen. Beim Welte-System geht es um weit mehr als um das Tempo, so wichtig es für die moderne musikwissenschaftliche Erforschung der Aufführungsparadigmen auch sein mag. Es umfasst auch Triller, saubere Notenrepetitionen, Schweller-Crescendi, Windausschöpfung und – mehr als alles andere – die Glaubwürdigkeit der Rollen als akkurate musikalische und wissenschaftliche Stellvertreter der Künstler, die sie zu Beginn des zwanzigsten Jahrhunderts eingespielt hatten.

Welte stellte äusserst genaue Aufnahmen her, wobei sie elektrisch anstatt pneumatisch angetriebene Motoren verwendeten. Die pneumatischen Motoren erwiesen sich nur beim Abspielen als problematisch.

Zum Mangel an Hinweisen zur Bestimmung der Präzision gesellt sich noch der Umstand, dass das System die konstante Rotation der Aufwickelspule und nicht die konstante lineare Bewegung des Rollenpapiers als Messlatte verwendete. Wenn das Papier aufgewickelt wurde, erhöhte sich die Geschwindigkeit schrittweise, bis sie, je nach Länge des Stücks, einen Faktor 2 oder 4 über der Startgeschwindigkeit lag.

Bei der Erforschung dieser Frage können wir auf eine Reihe von Informationsquellen und einige verwirrende Praktiken von Welte zurückgreifen, bei denen zuweilen die Rollengeschwindigkeit bei der Wiedergabe absichtlich variiert wurde. Eine kritische Herangehensweise erlaubt jedoch schnell, die unglaubwürdigen von den zuverlässigen Quellen zu trennen.

Ältere Wissenschaftler standen nur windmotorgetriebene Geräte zur Verfügung, um dieser Frage nachzugehen. Jetzt, da der New Yorker Aufnahmeapparat analysiert und so restauriert wurde, dass er äusserst zuverlässige Zahlen liefert, kann er einige der bisher zur Anwendung gebrachten Ansätze bestätigen oder zumindest stützen. Dies hat ausserdem zur Erkenntnis geführt, dass das Welte-Aufnahmesystem im Verbund mit modernen Scanning-Methoden und Computerwiedergabe die berüchtigte Störanfälligkeit des pneumatischen Welte-Motors vergessen machen kann.

David Rumsey

RÉSUMÉ

La vitesse des rouleaux d'orgue Welte

L'absence totale d'indications du facteur ou d'informations concrètes sur la vitesse exacte à laquelle les rouleaux d'orgue Welte étaient destinés à fonctionner, demande d'autres approches, si nous voulons utiliser ce paramètre important pour étudier les exécutions enregistrées sur rouleaux. Le système Welte va bien au-delà de la question du tempo, aussi essentiel soit-il pour l'étude musicologique moderne des paradigmes de l'exécution. Il englobe également les trilles, la clarté des notes répétées, les crescendos de la pédale d'expression, l'exploitation du vent et, le plus important, la crédibilité des rouleaux considérés comme les représentants aux plans musical et scientifique précis des artistes qui les ont enregistrés au début du 20e siècle.

Les enregistrements de Welte, qui utilisait des moteurs électriques et non des moteurs pneumatiques, étaient d'une remarquable précision. Les moteurs pneumatiques ne posaient problème que lorsque les enregistrements étaient joués.

À la rareté des informations dont nous disposons pour déterminer la précision s'ajoute un autre facteur aggravant : le système utilisait comme graduation la rotation constante de la bobine d'enroulement, et non le mouvement linéaire constant du papier du rouleau. La vitesse augmentait progressivement, au fur et à mesure que le papier s'enroulait, pour atteindre, fonction de la longueur du morceau, 2 à 4 fois sa vitesse de départ.

Pour étudier cette question, nous disposons de multiples sources d'information et de quelques curieuses pratiques de Welte, qui modifiait parfois la vitesse du rouleau à l'exécution. Mais un examen critique des sources permet rapidement de séparer les sources peu dignes de foi des sources fiables.

Autrefois, les scientifiques n'avaient que des dispositifs actionnés par un moteur éolien pour étudier cette question. L'appareil d'enregistrement de New York, maintenant qu'il a été analysé et restauré et est en mesure de fournir des chiffres extrêmement fiables, peut valider quelques-unes des approches entreprises jusqu'ici ou les confirmer de quelque autre manière. Ceci a par ailleurs permis d'aboutir à la conclusion que le système d'enregistrement Welte, associé aux méthodes de balayage modernes et à une exécution sur ordinateur, peut entièrement éliminer la sensibilité aux pannes notoire du moteur pneumatique Welte.

CHRISTOPH E. HÄNGGI UND KAI KÖPP (HRSG.)

'RECORDING THE SOUL OF MUSIC'

WELTE-KÜNSTLERROLLEN FÜR ORGEL UND KLAVIER ALS AUTHENTISCHE INTERPRETATIONSDOKUMENTE?

SYMPOSIUM SEEWEN 2013

Internationales Symposium des Forschungsschwerpunkts Interpretation der Hochschule der Künste Bern im Museum für Musikautomaten, Seewen SO vom 10./11. März 2013

IMPRESSUM

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